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NEW HAMPSHIRE AGRICULTURAL EXPERIMENT STATION

Progress of Agricultural Experiments-1922

A Report of the Director of the New Hampshire Agricultural Experiment Station for the Year 1922, Including a Financial Statement for the Fiscal Year Ending June 30, 1922

NEW HAMPSHIRE COLLEGE
OF
AGRICULTURE AND THE MECHANIC ARTS
DURHAM, N. H.

The New Hampshire Agricultural Experiment Station.

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Progress of Agricultural Experiments—1922

A Report of the Director of the New Hampshire Agricultural Experiment Station for the Year 1922, Including a Financial Statement for the Fiscal Year Ending June 30, 1922.

The past year has seen the farmer's purchasing power at its lowest ebb since the war. In December, 1921, according to the statisticians of the United States Department of Agriculture, the general purchasing power of farm products in terms of other commodities was only 62%.

The situation in New Hampshire has not been different from that in the rest of the nation. Farmers have found it more and more difficult to balance their expenses with milk checks and other sources of income. Long hours and tedious labor have in all too many cases made both ends meet only at the expense of soil fertility, fences, buildings, etc. There is no denying the fact that farming as a business has shown less and less of the margin of profit.

At such a time research work assumes, in the eyes of those interested in future agricultural welfare, an aspect of almost desperate importance. Upon the Experiment Station devolves the responsibility for determining what methods may best decrease the cost of production and so make possible a greater margin of profit. Improvements in seed and breeding stock, control of plant diseases and insect pests, tests of new and old varieties under New Hampshire conditions, the determination of the best combinations of soil and fertilizer, analyses of brands, etc., have a direct bearing on this problem; and the use of information of this type has come to mean almost the difference between success and failure in farming. Through the extension service, as well as through bulletins and newspapers, it is now possible to carry quickly the results of research work at the Experiment Station into practice in the state at large.

It is unfortunately true, however, that the economic disadvantages under which farmers labor have been growing so fast as to discourage many, as is shown by the 24 per cent. decrease in farms in the last decade. If the aggressive spirit, which is necessary under present conditions to make a success, is thus weakened, it is less likely to be receptive to new methods. It is all the more difficult to make headway when one is working against the current; and it is probably easier to convince a prospering man of profitable changes than one who sees his business losing daily. For this reason those who hope to see the agriculture of the state on a better paying basis must pin their faith to a long-time program. The tide is not easily nor quickly stemmed.

The function of the Experiment Station, therefore, must be not only to supply the necessary ammunition to the field force, but also to look ahead into the future and to join with the Extension Service in shaping a long-time program which will meet the needs of the coming decade. New Hamp-

shire is fortunate in having a closer relationship between extension and research workers than exists in most of the other states. The work in both lines is directed from the same office; the two staffs are kept in close touch with each other; and both join in an annual conference at which suggestions for the extension program and also the Station projects are carefully considered.

Hand in hand with the consideration of problems peculiar to New Hampshire also go those deeper investigations into the underlying causes of agricultural phenomena which are required by the Federal Adams Act. Through its Adams projects the Experiment Station makes its contribution to the national fund of agricultural science also with long-time results in view. Half of the Federal appropriations are expended in this type of work.

The appropriation by the State Legislature of $12,000.00 for the biennium has made it possible to hold the staff together and to maintain the projects in the face of the depreciated currency. It has not been sufficient, however, to effect the necessary broadening of the work, which the station must face, if it is to perform its maximum service to the agricultural interests of the state.

There are many problems crying out at the present time for research action which cannot be attacked with present funds. Among these are feeding experiments with beef cattle and dairy cattle (fattening experiments as distinct from the nutrition investigations in the respiration chamber); research in the interests of the poultry industry; laboratory work in animal pathology, and bacteriological studies of specimens sent to the station for analysis; research in the interests of forestry; a thorough-going handling of the apple scab menace; investigations in home economics; and research studies in the marketing problems.

Most important of all, however, is the need for investigations in various sections of the state relative to soils and crops. It is impossible to conduct locally the experiments which are needed to determine facts for the agriculture of these sections; this is partly due to soil and topographical conditions. The Experiment Station needs to establish plots in representative areas and to follow out on these plots a series of field experiments carefully planned and followed with minute accuracy and impartiality. Such experimental work would form the structure of extension work along this line during the next generation, and its importance to the agriculture of the state can hardly be overemphasized. Extension work has achieved its success and popularity largely because of the accumulation of knowledge which has not been previously built into the agricultural practice of the state; but unless we develop this foundation now into a superstructure for extension work along regional lines, we shall have failed in our leadership. While it would be desirable, if possible, to conduct investigations along other lines, such as those mentioned in the preceding paragraph, it is imperative that this fundamental work in soils and crops should not be longer delayed.

The report on the work for the past year will be considered by projects under the heading of the three main types of funds, Adams, Hatch and State, and Miscellaneous.

RESULTS OF WORK IN ADAMS PROJECTS.

Winter Injury of Apple Roots.

What happens when the roots of an apple tree are frozen, and what may be done to prevent such a condition? In investigating this problem G. F. Potter (Horticulture) has found several points of interest during the past year. The results to date indicate that it is not feasible through soil manipulation or cultural treatments to hope to reduce winter injury, except in so far as the use of a mulch or cover crop may prevent penetration of frost into the soil. On the other hand, different seedling roots have been found to vary widely, in their resistance to cold, some being very tender and some relatively hardy. While this difficulty cannot be overcome so long as seedling roots are used for propagation of the apple tree, the tests have shown that scion roots, especially those taken from the Hibernal and Duchess varieties, are very much more hardy than the seedling stocks. A considerable number of trees have been grown in the nursery under conditions which would tend to make them produce scion roots. This material was dug in the fall of 1922, and will be used for experimental purposes during the winter of 1922-23 and the season of 1923. The object of these tests will be to further establish the relative hardiness of different varieties of scion roots, and to test the feasibility of propagating named varieties upon vegetatively propagated scion roots rather than upon seedling stocks. If it is commercially possible to grow a tree upon a Duchess or Hibernal root stock, these trees will be of great value for planting in northern climates where more or less insidious injury to the root system of the trees occurs almost annually.

A discussion of the details of the experimental work may be helpful in showing the nature of this project. In the first place, the influence of the conditions under which the roots are frozen upon the resulting injury was studied in order to check results which had previously been obtained. All the roots were subjected to a temperature of minus 7.8° centigrade.

Before being frozen the seedling roots were stored at a temperature just above freezing, and as soon as they had been exposed to the test they were returned to storage under the same conditions. The injured tissues turned dark in from four to eight weeks, but roots uninjured by the low temperature were preserved in perfect condition until the following spring. In previous experiments the roots had been taken from cold storage and after freezing placed in a warm room under growing conditions. The new method of returning the roots to cold storage after exposure to low temperature gives much more reliable results, as is indicated by perfect preservation of the check roots which were not frozen. In one of the series the fall in temperature was a gradual one occupying about six hours, and the roots remained at a minimum temperature for one-half hour. In a second series the fall in temperature was at the same rate as the first, but the roots remained at the minimum temperature for a period of four hours; and in still another series the roots remained at the minimum temperature for eighteen hours. The average for nine separate tests showed that the roots exposed to the minimum temperature for one-half hour received an injury of about 27% while those exposed for an additional 3½ hours received an

injury of 31.5%, and those exposed for 18 hours showed an injury of 43.5%. Thus a gradual increase in the amount of injury is by no means proportional to the increase in the length of time of exposure.

A series of nine lots of roots were partially dried by exposing to the atmosphere of a storage cellar for 24 hours previous to the freezing test. When exposed to a temperature of minus 7.8° centigrade for one-half hour after a gradual fall, these roots showed an injury of only 12.8% or about one-half the injury which normal turgid roots receive under the same conditions.

A fourth series of roots was very suddenly frozen, the temperature being dropped to a minimum of minus 7.8° in about 30 minutes instead of six hours. These roots showed very much increased injury over those frozen under a gradual fall of temperature.

Tests were also made of the relative injury to roots frozen in dry sand, in saturated sand, and medium moist sand. The individual lots varied widely under these conditions. In the saturated sand, for instance, one lot showed an injury of 45%, while another showed an injury of 70.5%. It is evidently impossible to control the fall of temperature and other conditions in wet or moist sand sufficiently to get uniform results. The average injury for the series was greatest in the wet sand, and was greater in the moist sand than in the dry. This agreed with previous results although it must be remembered that the average is not accurate when so much individual variation occurs in different lots.

Another line of work under the winter injury project was a study of the structure of individual roots which had proved hardy in the tests of 1921 as compared to roots which had proved very tender in these same tests. Portions of the roots which had been placed in killing solution in 1921 at the time when the tests were conducted were embedded in celloidin, and microscope slides were prepared. A study was also made of one or two roots which had shown slight injury. The sections of roots showing injury indicate that the most tender tissue of the roots is the immature xylem. Cells of this region were killed and discolored when the other cells of the root were entirely uninjured. It was thought that the more hardy roots may be those which are best matured in autumn, and that the degree of maturity might be indicated by the number of actively dividing cells in the cambium layer and by the number of immature xylem and phloem on either side of the cambium. A considerable number of sections were prepared from each of 12 roots, but a study showed that there is no correlation between the number of immature xylem and phloem cells, and the resistance of the root to low temperature. No structural characteristics were found which would be associated with either hardiness or tenderness.

The results secured to date indicate that the environmental conditions during freezing such as length of exposure to cold temperature, the rate of temperature fall within limits which are possible under field conditions and the rate of thawing after freezing are of relatively small importance; the amount of injury depends most largely upon the degree of temperature to which the roots are subjected.

Fruit Bud Formation.

The work in the Woodman Orchard has been carried along by G. F. Potter and S. W. Wentworth on the same lines as in previous seasons. Total yield of fruit, average twig growth, and trunk diameters of the trees have been recorded. The more important plots are: (1) sod, (2) clean cultivation and cover crop, (3) cultivation and cover crop plus complete fertilizer. As has been previously indicated, the trees in the plots which receive complete fertilizer in addition to cultivation are now considerably larger than those trees which are cultivated but not fertilized. Yields of these plots are also somewhat larger, probably due simply to the increased bearing area, although there is some indication that the fertilized trees are bearing more regularly than the others. When the 1923 crop is harvested, the data for the third 5-year period on this fertilization experiment will be complete and it is expected that it will be published at that time.

The results of this experiment which have previously been published have been of great value to the state and have achieved national recognition. They have indicated that if an orchard is thoroughly cultivated, a complete artificial fertilizer does not give a sufficient increase in yield during the first ten years to pay commercially. They have also indicated that in the climatic conditions of New Hampshire the chief deficiency of a sod plot is in nitrate nitrogen. This form of plant food can therefore be applied to sod orchards as a chemical fertilizer with the result that growth and yields under sod culture are practically or fully as good as under a system of cultivation. The sod mulch with additional nitrate fertilizer is now becoming a standard practice in the sod orchards of New Hampshire, and the success of this system renders it possible to extend the orchard industry in New Hampshire to a much greater extent than would be possible if only those fields which are suitable for cultivation could be utilized as orchards.

The work on bio-chemical phases of fruit bud formation has occupied the major part of the time of the members of the staff and this work has been carried on in cooperation with H. R. Kraybill (Agricultural Chemistry) along the following lines:

Relation of Light to Fruit Bud Formation.

In the spring of 1921 trees on three plots of the Woodman Orchard were selected as follows: (1) sod plot, seven trees non-bearing the current year; (2) sod plot, seven trees bearing the current year; (3) high nitrate fertilized plot bearing fair crop. Four types of spurs were sampled from these trees at frequent intervals throughout the season as follows: (1) non-bearing spurs from non-bearing trees of sod plot; (2) bearing spurs, from bearing trees of sod plot; (3) non-bearing spurs from bearing trees of high nitrate plot, and (4) bearing spurs from bearing trees of high nitrate plots.

Samples were taken every week during the actively growing season, every two weeks later and finally every month until November. Composite samples in duplicate were taken from all of the trees of each plot, brought to the laboratory in tightly stoppered flasks, weighed and immediately preserved by heating in alcohol to which a weighed amount of $CaCO_3$, had been added.

The samples were then extracted, and the following determinations were made: moisture, free reducing substances, sucrose, maltose, starch, acid hydrolizable material, ash, total nitrogen, total phosphorus and potash.

The total leaf area of the leaves of the spurs was measured at each time of sampling. In the spring of 1922 counts were made upon the remaining spurs in each class analyzed of the number of spurs which blossomed and the number which failed to blossom. These blossom counts show the following results: (1) non-bearing spurs from non-bearing trees 1921 on sod plots, 10.4% blossomed in 1922; (2) bearing spurs from bearing trees in 1921 on sod plots, 0.0% blossomed in 1922; (3) bearing spurs from bearing trees in 1921 on high nitrate plots, 0.5% blossomed in 1922; (4) non-bearing spurs from bearing trees in 1921 on high nitrate plots, 40.0% blossomed in 1922. The chemical data is not completely tabulated and conclusions cannot be drawn at the present time. Significant differences in the different lots, however, in the per cent. of total nitrogen, starch, dry matter and ash are evident.

During the spring of 1922 Duchess apple trees were selected for the purpose of studying the effect upon the composition of fruit spurs of removing the fruit at blossom time. Three types of spurs were sampled from these trees at frequent intervals throughout the season as follows: (1) spurs bearing fruit from trees which had not been defruited and which bore a heavy crop of fruit; (2) spurs not bearing fruit from trees which blossomed heavily but which were defruited entirely at blossom time; (3) spurs not bearing fruit from trees which blossomed heavily but which had every other spur defruited at blossom time. In addition the fruit from spurs which were bearing fruit was sampled.

The samples were treated similarly to those of the previous experiment and the following determinations are being made: moisture, free reducing substances, sucrose, maltose, starch, acid hydrolizable materials, total nitrogen, total phosphorus and ash. In the spring of 1923 blossom counts will be made upon the spurs remaining upon the trees.

Leaf samples were taken and the leaf area of the spurs measured. Samples of the buds were taken also for morphological studies to determine the time of fruit bud initiation. Twelve samples were taken from May 12th to August 19th.

Nutrition Studies.

During the past year particular attention in the nutrition investigations with the new type of respiration chamber has centered on the influence of the degree of fill in the digestive tract of cattle, under varying conditions, on metabolism and on the true live weight. In other words, the studies have attempted to determine the true losses or gains in body tissue. Under normal conditions of feeding, animals show material daily fluctuations in the amount of feed and especially of water taken in. The same holds true but to a less extent of the waste matter voided. Hence a study of the energy metabolized and especially of the increases in body tissue (i. e. live weight) may give highly misleading deductions unless the influence of fill can be accounted for. It is rather remarkable that so little investigation is on

record to help establish the true basal metabolism under varying conditions of feeding. In fact until this is finally established, the whole mass of feeding experiments and teachings will still be open to great errors; and feeding standards may be subject to a certain measure of revision as they have been in the past.

From its beginning the main general objective of E. G. Ritzman (Animal Husbandry) and Dr. F. G. Benedict, director of the Nutrition Laboratory of the Carnegie Institution of Washington, who work in cooperation on this project, has been : (1) a study of the nitrogen balance and basal metabolism on various planes of nutrition, and (2) the development of improved and simplified methods and technique for studying basal metabolism.

An illustration of the effect which this work may have on economic stock feeding may be worth while. It has been generally accepted as a fact that animals digest food less thoroughly when fed heavy rations than on a lower feed level, but our investigations conducted under the most carefully controlled conditions indicate that in normally healthy animals the completeness with which a feed is digested is not influenced by the quantity consumed.

A technical treatise covering the first two years' work on the physiology of basal metabolism under maintenance, prolonged sub-maintenance, and heavy fattening rations has been prepared for publication as a monograph of the Nutrition Laboratory of the Carnegie Institution of Washington; and a more abstract treatise in the form of a Station Bulletin will also be prepared.

During the coming year it is proposed to continue the investigations on basal metabolism along the same general lines as in the past but to emphasize especially (1st) the influence of environmental temperature on metabolism and (2d) improvement of technique by the addition of a gas analysis apparatus for determining the oxygen consumption by the animal during a respiration experiment. This apparatus, designed by the Nutrition Laboratory, has already been successfully tested and its use will place the measurement of the respiratory exchange on a new and decidedly advanced level.

Sheep Breeding Experiments.

In developing the new phases of the sheep breeding work Mr. Ritzman has made a rigid selection in the breeding flock. All undesirable individuals of the second and third generation off-spring have now been eliminated and those kept are still subject to further culling during the year. These two generations of Mendelized off-spring from Southdown and Rambouillet ancestors present a remarkable uniformity in a general sense as live stock is judged. In size, character of fleece, and early maturity they have shown much less differentiation than might have been expected. An average flock in any of the standard breeds would hardly present a more uniform appearance.

In size the F_2 and F_3 generations average somewhat smaller than F_1. In fact their size is about equal to that of their Southdown ancestry. While not equal to good Southdowns in conformation they are reasonably compact and in this respect easily excel the F_1 and the Rambouliet.

A preliminary report on F_2 has already been published in technical Bulletin No. 16, but a supplementary and more complete report on the second and third generation offspring will be issued during the coming year.

The results in wool inheritance have been especially gratifying. There has been no marked evidence toward segregation in the quality of the wool; about 75 per cent. of the clip has been classed by expert graders as ½-blood staple and nearly all the remainder as 3-8 blood. Only one fleece as low as ¼-blood has so far been obtained, and only four fleeces have reverted to the finer Delaine. About 90 per cent. of the fleeces had a sufficient length of staple to sell as combing wool. While the wool approaches Rambouillet quality in fineness, crimp, and length, it carries much less grease than the latter; this fact in a measure accounts for the difference in fleece weights, the average being between 7 and 8 pounds per head.

Careful periodical weighings of all individual lambs indicate that up to four or five months the rate of growth varies primarily with variation in milk yield of the dam. Consideration of this highly important factor together with that of fecundity has had to be postponed in the past, since the limited number of animals used did not permit selection for a large numberof characteristics at one time.

It is planned, therefore, to continue the sheep breeding project on the Mendelian principle of hybridization as in the past, but to center the main attention on the study of the inheritance of fecundity and higher milk yield. These studies will be timely not only because of their economic importance; the development of the inherited potentialities for growth is dependent on a bountiful milk supply for the young, and this factor, if disregarded, may vitiate the most carefully conducted investigation.

A Rambouillet ram and twenty-one Oxford ewes have been purchased for this phase of the investigation. The Rambouillet parent was, of course, selected because of the fine wool and heavy fleece. The Oxford females were chosen because ewes of that breed are good milkers, and because they often show high fecundity, and at the same time possess a reasonably good mutton conformation.

Control of Root Maggots.

The investigations for the crop season of 1922 conducted by W. C. O'Kane and P. R. Lowry (Entomology) fully corroborated the results secured in 1921 and 1920 and brought this project to the point where further publication is in order, covering the work with the tobacco-dust-lime mixture.

Earlier in these investigations, when the studies included a number of different materials, one of the treatments that gave promising results was a dry mixture of tobacco dust and calcium carbonate. The studies of 1920 and 1921 were designed to throw light on the causes lying behind the results obtained with this material. Interesting and important facts were secured as noted in the 1921 report.

The experiments carried out the past season were in the main parallel to those of the preceding two years. Some new details were brought in, suggested by the results of 1921. The data of 1922 fall closely in line with the results of the preceding two years and show clearly the following:

1. Adult flies of the cabbage root maggot do not lay eggs freely on or near plants freshly treated with the tobacco-dust-lime mixture.

2. When eggs are laid in contact with tobacco-dust-lime mixture, a large percentage of non-hatch results. In the work of 1922 the non-hatch was 100% in the case of eggs placed in contact with the mixture, whereas the non-hatch was 0% in the checks, where eggs were placed in contact with soil.

3. The heavy percentage of non-hatch persists whether the eggs are placed on the surface of the mixture or are inserted slightly below the surface.

4. The percentage of non-hatch is high whether the material remains dry or is wet down. The results indicated no difference due to the addition of moisture.

5. Protection to cabbage plants in the field from the use of the mixture diminishes rapidly when heavy rains intervene. This appears to be due largely to the fact that rain packs the mixture down and the movement of the cabbage plant in the wind then opens a small space next to the stem. The female fly drops eggs down into this space.

6. Protection of cabbage plants during the first two or three weeks after they are set out is the most important phase of the treatment. The plants will withstand heavy attack by maggots after they have established their root system. This protection of newly-set plants is readily attained by the use of the tobacco-dust-lime mixture.

7. Protection of plants that are drilled in, such as radishes, is easily secured by the use of the mixture. Such plants do not sway in the wind as do cabbage plants. In 1922 the percentage of radishes free from maggot attack or only slightly infested in the treated rows was 81.2, whereas the percentage in the untreated rows was 45.5.

The department believes that the investigation has now resulted in a practical treatment for cabbage, radishes, turnips and cauliflowers, which will give them reasonable protection without in any way injuring the plants or retarding their growth. The treatment is easily and quickly applied. The ingredients are cheap. In the case of cabbage and cauliflower the protection afforded carries the plants through the critical period following transplanting; in the case of radish and turnip it affords a satisfactory means of insuring a marketable and profitable crop.

The tobacco-dust-lime phase of the root maggot studies is considered to be ready for publication, and a bulletin is in preparation.

How Bordeaux Mixture Stimulates Plants.

The past year has seen the completion of the studies on the stimulatory action of Bordeaux mixture. The investigations of O. Butler (Botany) in this field show that the physiological response of plants to the mixture depends on the intensity of the shadow cast by the wash. The amount of lime present in the mixture proved the important factor here. Bordeaux mixture 1:1 was found to act as a depressant but Bordeaux mixture containing just enough lime to give an alkaline reaction permitted normal de-

velopment in the sprayed plants. A milk of lime wash of the same strength in lime as a 1:1 Bordeaux mixture had practically the same effect upon the sprayed plant as the latter. The fertility of the soil in which the plants were growing did not affect the response obtained, but spraying with a 1:1 mixture had a beneficial effect when the plants sprayed were grown in soil much too dry for normal development.

It has been stated that plants sprayed with Bordeaux mixture transpire more actively at night than non-sprayed plants; and it was found that when 1:1 Bordeaux mixture increased transpiration at night, a 1:alk mixture and a milk of lime wash caused a similar response. The increased transpiration that occurs at night is not the cause of the differences in behavior observed between sprayed and non-sprayed plants; for Bordeaux mixture 1:1 and milk of lime have a similarly depressing effect upon vegetation, while Bordeaux mixture 1:alk is neutral in action. The effect of Bordeaux mixtures and milk of lime on plants at night, therefore, is less important than the effect produced by these washes during the day time. In fact, it was observed that sprayed plants do not necessarily transpire more actively during the night time. Evidently Bordeaux mixtures and milk of lime possessed under conditions of darkness properties in common and under conditions of sunlight dissimilar properties. And, in fact, it was found that Bordeaux mixture 1:1 and milk of lime were less transparent to the solar spectrum than Bordeaux mixture 1:alk, but that the Bordeaux mixtures and milk of lime were opaque to radiations of long wave length, Bordeaux mixture 1:1 and milk of lime being more opaque than Bordeaux mixture 1:alk. Therefore, under conditions favorable for radiation at night, sprayed plants should transpire more than non-sprayed plants and it was found that they actually did so.

The Adhesive Quality of Copper Acetates.

Further investigation into the basic action of spray materials was made by O. Butler (Botany) and T. O. Smith (Agricultural Chemistry) in connection with the study of the adhesiveness of copper acetates. It is known that the decomposition of the copper acetates upon the sprayed plants causes their adhesiveness, and the present work has been to determine both the effect of duration of drying, and the effect of an addition of gelatine. One per cent. mixtures of both neutral and basic acetate of copper were sprayed on glass slides; and the interval between the application of the wash and the incidence of rain was from 24 hours to 15 days. When the mixture did not contain .05 per cent. gelatine, the data obtained showed that the decomposition of the neutral acetate measured in terms of adhesiveness is roughly proportional to time; in the case of the basic acetate of copper the rate of decomposition is extremely rapid during the first four days but continues from thence on more slowly. The adhesiveness of the neutral acetate of copper never became equal to that of the basic acetate of copper. When gelatine was added to the washes, the adhesiveness of the neutral acetate of copper became at the end of forty-eight hours virtually the same as that of the basic acetate plus gelatine and was only slightly lower at each of the

subsequent periods of observations. The addition of the .05 per cent gelatine greatly increased the adhesiveness of both the basic and neutral salts, the more marked effect being produced upon the latter.

The Action of Sulphur Fungicides.

The nature of the action of sulphur fungicides is coming to be more and more of a critical problem, particularly in regard to the control of apple scab; and W. L. Doran (Botany) has pursued during the past year a study of the conditions under which these fungicides are toxic to parasitic fungi. It was found that sulphides are extremely toxic, but that since the polysulphides decompose rapidly on drying their value is merely a contactual one. Data were gathered on the relation between temperature and the time required for sulphur to kill, and it was found that sulphur was more active at high than at low temperatures. Sulphur was found to be toxic only when it acted in the presence of oxygen.

Plant Metabolism Studies.

The relation of nutrition to fruit production has received a great deal of attention during the past few years, particularly among horticulturists, who have given special attention to this problem in its relation to the apple. H. R. Kraybill and T. O. Smith have been studying the effect of varying the supply of nitrogen, phosphorus and sulphur upon growth and fruit production, using the tomato plant in all of the work. As mentioned in the last report two sets of plants have been grown in sand in the greenhouse. The first set consisted of four lots of plants receiving the following nutrient solutions: lot 1, complete nutrient solution; lot 2, nutrient solution without nitrogen; lot 3, nutrient solution without sulphur; and lot 4, nutrient solution without phosphorus. The second set was a duplication of the first set except that an additional lot was grown with a very small amount of phosphorus in the nutrient solution, and grown at a different season of the year. Samples of the leaves and stems of the plants were preserved for analysis. The work during the past year has dealt entirely with the analysis of these samples.

Samples of plants grown under each treatment were preserved with alcohol and $CaCO_3$. Free reducing substances, sucrose, maltose, starch and acid hydrolizable material were determined in each of these samples. Other samples are being analysed by the Koch method of tissue analysis, which consists of separating the sample into three fractions as follows: F_1 Lipoid fraction, F_2 water and 80% alcohol solution fraction and F_3, the water and alcohol insoluble fraction. The nitrogen distribution of these fractions is being studied; and if sufficient material is at hand, the phosphorus and sulphur distribution will also be included.

HATCH AND STATE PROJECTS.

Timothy Improvement Work.

In addition to observations on the field trials in the various counties of the strain of timothy developed at the Station, further selection has been made by F. W. Taylor (Agronomy). Twenty of the best and most ideal plants in the testing plot were chosen in July. These plants were allowed to mature their seed, which was planted in separate rows the latter part of August. In the spring of 1923 a hundred or more plants from each of these rows will be set out in a new testing plot for further selection.

In the spring of 1921 several 2-lb. lots of the selected strain were sent to county agents for test plots alongside of an improved strain from Ohio and of ordinary commercial seed. While no very definite comparisons can be made until next year, at least one plot inspected in July showed the New Hampshire strain to be earlier, taller, more erect and with longer heads than the other two strains. These characteristics of growth, together with leafiness, have been the aims of the process of selection and were to be expected.

Variety Tests of Ensilage Corn.

Continuing his tests of ensilage corn, Mr. Taylor planted thirteen varieties of corn and one of sunflowers June 1, four rows to the plot and 600 feet long. Portions of the land were not well drained and on account of the extremely heavy rainfall (12.1 inches falling between June 3 and July 6) the growth of the corn was so delayed and uneven that no data on yields could be obtained. The following table shows the varieties planted and their comparative state of maturity at the time of cutting, September 22.

Variety	State of Maturity
Eureka	Just "shooting"
Improved Leaming	In milk
Leaming	In dough
Reid's Yellow Dent	In milk
Early Lakeside	In dough
N. H. 500	Glazing
Sweepstakes	In milk
Red Cob	Kernels just forming
Pride of the North	In dough
Brewer's Yellow Dent	In milk
Luce's Favorite	In dough
Minnesota 13	Glazing
Sanford	Glazing

The chemical analyses of the samples of silage made from the several varieties grown in 1921 and submitted by the Station Chemist, Mr. Kraybill, are given below.

The several varieties of corn were cut and siloed Sept. 17. Samples of each variety were bagged and taken out of the silo in mid-winter for analysis. The latter part of the season of 1921 was very dry and the moisture content

of the corn was relatively low at cutting time. The samples marked with an asterisk were well matured. Eureka, Cuban Giant and Luce's Favorite were relatively immature. The maturity and dryness of the corn explain the comparatively high percentage of fat and protein.

1921 Ensilage Samples—Computed to Green Weight Basis

Sample No.	Moisture	Fat	Protein	Carbohydrates	Ash
Eureka	76.55	1.11	1.93	19.34	1.07
*Cornell No. 11	63.49	1.76	4.19	29.40	1.16
Imp. Leaming	74.27	1.24	2.47	21.05	0.97
Leaming	73.95	1.24	2.81	21.10	0.90
Cuban Giant	76.41	0.94	2.05	19.70	0.90
Clarage	75.43	1.13	2.53	20.04	0.87
Red Cob	76.17	1.25	2.21	19.39	0.98
*N. H. 500	65.06	1.83	4.07	28.02	1.02
Brewer's Dent	73.03	1.49	2.44	21.94	1.10
Early Lakeside	72.25	1.70	2.76	22.31	0.98
*Webber Dent	71.68	1.75	2.41	23.11	1.05
*Minnesota 13	69.94	2.01	3.18	23.68	1.19
*Early Yellow Dent	69.87	1.88	2.77	24.40	1.08
Luce's Favorite	84.40	0.82	1.74	12.43	0.61
*Pride of North	70.84	1.36	2.84	23.83	1.13
*Sanford	62.64	2.34	4.57	29.40	1.05
Sunflowers	73.61	1.56	3.13	20.29	1.41

Soil Rejuvenation Studies.

This project was started in 1920 by M. G. Eastman (Agronomy) and H. R. Kraybill (Agricultural Chemistry) for the purpose of studying the effects of the use of green manures and fertilizers on the productivity of neglected lands which have been cropped in hay continuously for a long period of years. The plots, one quarter acre in size, are located upon a sandy loam soil and run in duplicate. Previous to the planting the lime requirement of the soils of each plot was determined by the Veitch method and ground limestone to the extent of 80 per cent. of the requirement was applied:

The plot treatments are as follows:

No. 1—Fall plowed and seeded to rye and vetch; this crop plowed under in the spring and seeded to oats and clover, timothy and red top.

No. 2—Fall plowed and seeded to rye and vetch, this crop plowed under in the spring and seeded to oats and peas to be plowed under in later summer and again seeded to rye and vetch to be plowed under the following spring, when the plot is to be seeded to oats with timothy, clover and red top.

No. 3—Same as No. 2 except that buckwheat and soy beans are substituted for oats and peas in the series.

No. 4—Fall plowed and seeded to oats with clover and timothy the following spring.

In order to study the effect of certain mineral fertilizers each of the foregoing plots was divided into five sections, which were treated as follows:

a. With raw rock phosphate and gypsum.
b. With acid phosphate.
c. With nitrate of soda, raw rock and gypsum.
d. With nitrate of soda and acid phosphate.
e. No treatment.

The tiers of plots number 1 and 4 were seeded to oats, clover, timothy and red top in the spring of 1921. The oats were cut in 1921. The tiers of plots numbers 2 and 3 were seeded to cover crops as given in the outline of treatment of plots. The cover crops were plowed in during August, and the tiers of plots numbers 2 and 3 were seeded to rye and winter vetch. In the spring of 1922 the rye and vetch was plowed in, and the plots were seeded to oats, clover, timothy and red top. Because the season was marked by an unusual amount of rainfall, the date of seeding was delayed materially. In the summer of 1922 the hay was cut on the tiers of plots numbers 1 and 4 and the air dry weight determined. The results are rather irregular possibly due to the unusual amount of rainfall; and the probable errors are too large to draw conclusions relative to the different mineral fertilizer treatments. All of the mineral fertilizer treatments, however, gave decidedly larger yields than the no-fertilizer treatments; and the yield of all of the plots was much higher than the yield of untreated plots taken from land adjacent to the experimental plots. The average yields for the plots of the different treatments ranged from 2124 pounds per acre for no fertilizer to 2724 pounds per acre with mineral fertilizer, while the yield of the adjacent land was only 335 pounds per acre.

A similar series of tests was begun on a second two-acre tract in the fall of 1921. The second tract is a heavy clay soil, low lying, which has not been plowed or fertilized for more than forty years. On account of the wet weather it was impossible to continue the test on this tract of land according to the plan, but it was seeded with rye late in the fall of 1922. At the present time there is a good stand of rye, and it is planned to continue this during the coming year according to plans except that the schedule of treatments will be one year later.

Potash Tests on Potatoes.

For several years the College Farm has manured its potato ground at the rate of 16 spreader loads to the acre and supplemented this manure with 1200 lbs of a 4-8-4 fertilizer made up of nitrate of soda, sulphate of ammonia, tankage, acid phosphate, and muriate of potash.

In order to secure data on the effects of both less and larger amounts of potash, quarter-acre plots were laid off across the field, on each of which 6 rows of potatoes were planted. While the data is for one year only and therefore not conclusive, the indications are that the larger amounts of potash formerly used are not necessary with reasonable applications of stable manure.

Top-dressing Hay Land.

As a continuation of some former experiments in top-dressing grass land, six one-quarter acre plots were laid out last spring by Mr. Taylor on a piece of clay meadow which had been seeded down in 1919. The hay, which

was about 90 per cent. timothy and red top, was cut July 15 and stored the 17th. The following tabulation indicates the kind and amount of materials applied and the yield of hay per acre:

Material	Amt. per acre	Yield, hay per A.
Nitrate of Soda	200 lbs	4072
Sulphate of Ammonia	150 lbs.	4072
Calcium Nitrate	232 lbs.	3932
None	Checks	3200

The sulphate of ammonia was applied April 22; the other material May 6, at such rates as to give each plot an application of 30 lbs. of nitrogen per acre.

Pasture Improvement.

In order to supplement the results obtained in some previous pasture improvement experiments an acre of land in the old reservoir pasture was cleared of brush, briars and juniper. This was divided into eight sections 50 x 110 feet each. The sections were treated as follows:

1. Nitrate of Soda..... 160 lbs. per acre.
2. Nitrate of Lime..... 184 lbs. per acre.
3. Ground Limestone.....4000 lbs. per acre.
4. Check.....No treatment.
5. Grass seed alone.....16 lbs. per acre.
6. Grass seed and Nitrate of Soda as above.
7. Grass seed and Nitrate of Lime as above.
8. Grass seed and Ground Limestone as above.

The Grass seed mixture was made up of—

15 lbs. Timothy.
15 lbs. Ky. Blue Grass.
10 lbs. Red Top.
10 lbs. Red Clover.

The grass seed was sown April 15 and the fertilizer applied May 1.

The effect of the nitrogen fertilizers could be noted throughout the season, while that of the limestone and grass seed, as was to be expected the first season, could not. It is planned to repeat the applications of fertilizer on the same sections again next season for further observation.

Foreign Clovers.

Duplicate plots of Bohemian, Chilean, German, Hungarian and Italian red clovers supplied by the Bureau of Plant Industry, Washington, D. C., were sown June 1st. Two local red clovers under the names of Krop-King and Eureka, and presumably native, were planted at the same time with the idea of observing differences between native and imported clovers in growth and adaptation to local climatic conditions. A reasonably good stand on all the plots has been obtained, reports Mr. Taylor, with the possible exception of the Hungarian, and very little consistent difference in develop-

ment to date. The plots of Hungarian do not seem to be as good as the others.

Two plots each of red clover and alfalfa received direct from Italy have developed poorly or not at all. More conclusive data on these tests will be available after the plots have gone through at least one winter.

Lime Requirements of New Hampshire Soils.

The importance of lime in the development of the extension project for more legumes in the state has been emphasized more and more during the past few years; and again during the past year a general series of soil tests was conducted for the various counties by the Agricultural Chemistry Department. The county agents take, according to directions furnished by the department, samples of soil which the farmers wish to have tested, fill out descriptive sheets giving the location and characteristics of the soil and send them in to the Station. The samples are tested as soon as received by means of the Truog method, and the results reported to the county agents so that they are immediately available for the farmer. These samples of soils are carefully preserved and kept for future studies.

The following table shows the summary of the results of the past two seasons' work:

County	No. of samples			Acreage represented			Average lime requirement by Truog test for crop intended to be planted in lbs. ground limestone per acre	
	1921	1922	Tot.	1921	1922	Total	1921	1922
Merrimack	93	88	181	255	258	513	5,500	4,000
Belknap	52	22	74	345	33	378	6,000	6,500
Strafford	39	10	49	188	.....	188	5,300	.....
Rockingham	35	71	106	60	235	295	6,500	5,600
Sullivan	10	.....	10	10	.....	10	6,000	.....
Hillsboro	23	48	71	121	232	353	6,000	4,000
Carroll	.....	60	60	.....	452	452	.....	4,200
Grafton	.....	36	36	.....	259	259	.....	3,000
Totals	252	335	587	979	1,469	2,448	Ave. 5,900	Ave. 4,550

The Methylene Blue Method of Estimating the Keeping Quality of Milk.

The plate method of estimating bacteria in milk is generally used in the belief that it gives the most satisfactory index (1), of the keeping quality of milk and (2), of the conditions under which it has been produced and handled. However, many of the smaller cities and city milk plants of the state lack the necessary laboratory facilities for running the plate method. With a view, therefore, of determining a whether satisfactory index may be ob-

tained by another process, J. M. Fuller and H. F. DePew (Dairy Husbandry) have been studying the possibilities of the methylene blue method. This method is known to have the advantages of requiring less apparatus, less time, and less technique. The chief question has been as to the accuracy of the methylene blue test as compared with the plate method or other methods that might be used in obtaining the desired index.

Preliminary work that has been done during the past year indicates that the methylene blue test does give a satisfactory index. Results also indicate that there is a fairly definite relation between the reduction time of the methylene blue test and the number of bacteria as shown by the plate method. For example, a reduction time of 3 hours or less corresponds to a bacterial count of 500,000 or more per c. c.; a reduction time of from 4 to 7 hours, approximately 150,000 bacteria per c. c.; and a reduction time of 8 hours or more, under 25,000 bacteria per c. c.

In continuing this project, more emphasis will be given to a comparison between the keeping quality of samples used and the reduction time. The relation between the bacterial content of milk and the reduction time will be studied.

Forest Research Work.

The research work in forestry, inaugurated in 1913 under the Hatch Act, consists in experimental work along the following lines:

(1) Plantations of native and exotic tree species suitable to the climate of southern New Hampshire to determine their rate of growth.

(2) Plots marked off in acres of natural regeneration of white pine and mixed hardwoods to determine the relative rate of growth.

(3) Thinning of immature stands of white pine to improve the quality and rate of growth.

Plantations of white ash, red pine, European larch, Norway spruce, Douglas fir and Scotch pine have been made; but only the last three have been markedly successful. The others were either made on unsuitable sites or have been injured by subsequent logging operations.

The sample plots in the mixed stands of hardwood and white pine show conclusively, finds K. W. Woodward (Forestry) that white pine does not grow as rapidly in the first ten years as do black birch, red maple, red oak, paper birch and similar hardwoods, and that it must be freed from the competition of these latter species if it is to survive.

The plots have been measured annually since their establishment in 1913 except for a hiatus in 1917 and 1918 due to war conditions. They vary in size from ½ to 1-640 of an acre. As far as possible they are located in the college woods.

Effect of Phosphorus upon the Yield and Time of Maturity of Tomatoes.

One of the most important factors in determining the commercial success of growing tomatoes for market is the time of maturity of the crop. Frequently the first portion of the crop may bring much more in money return than the mid-season portion, even though the total yield of the latter

portion may be much the greater. This is due to the higher prices which prevail early in the season when the supply is limited. Under conditions such as prevail in New Hampshire, frequently the latter part of the tomato crop is lost by frost injury because of the relatively short growing season.

This project was continued by J. R. Hepler (Horticulture) and H. R. Kraybill (Agricultural Chemistry) in 1921 to determine whether the application of phosphorus fertilizers would hasten the maturity of the tomato. The fertilizer treatments of the plots were as follows:

Plot 1— 40 tons of manure per acre.
Plot 2— 20 tons of manure per acre.
Plot 3— 20 tons manure per acre.
1000 pounds acid phosphate per acre.
Plot 4— 20 tons manure per acre.
1000 pounds gypsum per acre.
Plot 5— 20 tons manure per acre.
500 pounds acid phosphate per acre.
Plot 6— 20 tons manure per acre.
1000 pounds acid phosphate per acre.
1000 pounds muriate of potash per acre.
Plot 7— 20 tons manure per acre.
1000 pounds muriate of potash per acre.
Plot 8— 20 tons manure per acre.
1500 pounds acid phosphate per acre.

There were four duplicate plots of each treatment. Records of the number of fruit and weight at each picking time were kept for each plot. The number of blossom clusters, the number of blossoms per cluster, the number of fruit set and the number of fruit ripened were recorded for 12 plants of each plot.

The following table shows the average yield of the four plots of each treatment and the probable error, and a comparison of the yields of the different treatments with the yield of the plots treated with 20 tons of manure per acre and the probable errors. Up to September 13th the yield of all the plots receiving acid phosphate and the plots receiving extra manure were decidedly larger than the yields of the plots treated with manure alone. The yield of the gypsum plots was slightly more and of the muriate of potash was slightly less than of the manure-alone plots. The data show that the application of acid phosphate in addition to the manure hastens maturity and also increases the total yield per acre. The extra manure plots gave the highest total yields for the season but the yields early in the season were not so high as those of the acid phosphate treatments. The application of muriate of potash showed no appreciable increase in yield.

TABLE SHOWING RESULTS OF APPLICATION OF PHOSPHORUS FERTILIZERS ON TOMATOES.

Treatments Amounts per acre	Yield in pounds of fruit per acre up to Sept. 13th		Yield in pounds of fruit per acre up to Sept. 26th		Yield in pounds of fruit per acre for the season	
	Average of four plots*	Difference in yield from that of manure alone* (20 tons)	Average of four plots *	Difference in yield from that of manure alone*	Average of four plots *	Difference in yield from that of manure alone*
Manure 40 tons	2920 (23)	+416 (32)	9273 (550)	+3665 (748)	37036 (2134)	+17888 (2772)
Manure 20 tons	2504 (23)	.....	5608 (507)	.....	19148 (1769)	.....
Manure 20 tons and 1000 lbs. acid phosphate	3456 (366)	+952 (367)	9832 (829)	+4224 (972)	25291 (613)	+6143 (1872)
Manure 20 tons and 1000 lbs. gypsum	2849 (229)	+345 (230)	6369 (403)	+761 (648)	23379 (1726)	+4231 (2471)
Manure 20 tons and 500 lbs. acid phosphate	3053 (134)	+549 (136)	8318 (716)	+2710 (877)	29270 (1585)	+10122 (2375)
Manure 20 tons, 1000 lbs. acid phosphate. and 1000 lbs. muriate of potash	3371 (199)	+867 (200)	8889 (428)	+3281 (664)	34300 (1310)	+15152 (2201)
Manure 20 tons and 1000 lbs. muriate of potash	2339 (126)	−165 (128)	5629 (175)	+21 (536)	22075 (2044)	+2927 (2703)
Manure 20 tons and 1500 lbs. acid phosphate	3537 (202)	+1033 (203)	10479 (263)	+4871 (571)	34691 (380)	+15543 (1809)

*Probable error, plus or minus, in each case is stated in parentheses.

Spraying for Apple Maggot.

For the third season a study to shed further light on the effects of spraying with arsenate of lead and water was made by W. C. O'Kane.

The plan of the experiments includes thorough spraying of all apple trees in an area that is protected by natural boundaries from ingress of flies migrating from unsprayed trees. No attempt is made to attract the flies by means of bait. The purpose is to distribute drops of poison spray over the foliage in such abundance that any female flies sipping moisture from the foliage will be poisoned before they have had opportunity to lay eggs.

Trustworthy information is difficult to secure in the case of this insect. Its abundance fluctuates in marked degree from year to year. It may be numerous in a given locality for a series of seasons and suddenly become relatively scarce. Fruit may be badly attacked in a certain area and relatively free from attack in another area near by. For these reasons it is necessary to exercise special caution in drawing conclusions from records of infestation following spraying. If the species turns out to be scarce in orchards where spraying is carried out, the lack of abundance may be a result of the spraying or may be due to some other cause. The factors that enter into the matter are so complex and often so obscure that positive conclusions are exceptionally difficult or may be entirely out of the question.

In view of these circumstances, the present investigation is being continued for several seasons; and any interpretations or conclusions will be withheld until the work is completed.

In the crop season of 1922 experimental spraying was carried out in three different areas. In each of these areas the infestation by apple maggot was light; whether this was due to the spraying or to other causes cannot be safely asserted.

Control of Black Flies.

In the fall and winter of 1921 facts of unusual interest were secured in the life history of black flies. A considerable number of streams have been observed by Mr. O'Kane in the course of this study. Notes have been taken at rather frequent intervals, showing the abundance of larvae in the streams, the relative amount of stream flow, the temperature of the water and other data. Specimen larvae have been collected in each case and the species determined.

In the late fall of 1921 a long-continued drouth caused various streams to dry up where black flies normally breed in numbers. These breeding grounds were kept under careful observation and were visited after the first snows had fallen. They were again visited early in 1922, and at intervals as the spring and summer progressed. The result is a series of records which shed new light on the seasonal abundance and the breeding habits of black flies.

The breeding points in question will be kept under observation until the winter season of the current year. It is expected that the results of the general study will then be published.

Insect Record.

The most notable information recorded in this project is the increased spread of the European Corn Borer, *Pyrausta nubilalis*. Many specimens of borers in various plants have been sent to the entomology department in the course of the past year. Nearly all of these proved to be the native stalk borer, *Papaipema nitela*, which continues to be unusually abundant. This native insect is not considered to be a serious menace; but the imported species, on the other hand, is considered by the department to be the most dangerous insect that has threatened American agriculture in many years. Its further spread into New Hampshire has been fought by quarantines maintained by the Federal Bureau of Entomology and by the State Division of Insect Suppression. But the adult moths are able to fly readily; there are two generations a year; and the number of plants in which the species will breed is exceptionally large, including practically all weeds, garden vegetables and flowers that have a succulent stem large enough to contain the borer. The insect is rapidly extending its range in New Hampshire and will undoubtedly have to be dealt with in increasing degree.

The gypsy moth, *Porthetria dispar*, was exceptionally abundant in certain localities. The browntail moth, *Euproctis chrysorrhea*, was found over a larger area than last year and appears to be definitely on the increase.

Apple Scab.

Experiments were carried out by Messrs. Butler and Doran in two McIntosh orchards in which apple scab had proved extremely injurious the previous year, verdigris and various types of Bordeaux mixture being used. In one orchard 4 applications of the fungicides were given, the pre-pink, pink, calyx and 2-weeks-after-the-calyx sprays; in the other orchard the pre-pink spray was omitted. The best control was obtained in the orchard in which the pre-pink was used.

Effect of Climate on Productiveness.

An experiment was started for the purpose of studying the behavior of northern grown potato seed comparatively with potato seed grown in southern New Hampshire from the same strain.

Spraying Potatoes.

In the potato spraying work, experiments were conducted on the effect of pressure and number of nozzles used on the control of late-blight. The potatoes were sprayed four times with 8-4-50 Bordeaux mixture applied every two weeks, but late blight did not develop in the field and no data was obtained. It was, however, noted that neither the number of nozzles used nor the amount of mixture applied per acre had any "stimulatory" effect on the yield of the plants.

Bean Anthracnose.

Experiments were made by Mr. Doran on the control of anthracnose by heating diseased seed for 2 hours at 80°C., by dusting and spraying with Bordeaux mixture, and covering the plants during the rainy weather

until the cotyledons had fallen. Spraying with Bordeaux mixture gave better results than dusting, and covering the plants gave a very satisfactory degree of control. Heating diseased seed was not found to give the same degree of protection as the other methods tried.

Snapdragon Rust and Its Control.

Experiments on the field control of the snapdragon rust have been continued by Mr. Butler, and it has been definitely ascertained that neither sulphur nor the copper fungicides will afford the necessary degree of protection. The copper fungicides are not sufficiently toxic to prevent the germination of the spores, and the temperature prevailing during the spring at Durham is not high enough for sulphur to act.

Small Fruits Project.

The usual records were taken on the raspberry and blackberry variety and fertilizer experiment. As in previous seasons Herbert proved to be the best of the red raspberries planted. Snyder proved a better blackberry under conditions at the Station than did Eldorado. No definite conclusions can be drawn as yet as to the result of the various fertilizer applications, which include both top dressing with manure and fertilization with complete chemical fertilizers.

As a new part of this project an experiment has been begun on the use of nitrate of soda as a fertilizer for strawberries; but results are not significant for this year's test.

Soil Fertility in the Garden.

The soil fertility garden plots, which are being studied over a period of years by Mr. Hepler, were planted to Bountiful bush beans, grown for the green pods for canning purposes. They were planted June 15. Plots 3 and 7, the green manure plots, were plowed early and planted with oats, which were nearly a foot high when turned under. The season was very wet, but the yield was not appreciably affected. The data are recorded in pounds of snap pods per plot.

The different plot treatments are as follows:

Plot 1—32 tons of manure per acre.

Plot 2—24 tons of manure per acre and the following commercial fertilizers per acre:

150 pounds	Tankage.
100 "	Nitrate of Soda.
600 "	Acid Phosphate.
150 "	Muriate of Potash.

Plot 3—Green manure plus the following commercial fertilizers per acre:

160 pounds	Nitrate of Soda.
250 "	Tankage.
800 "	Acid Phosphate.
300 "	Muriate of Potash.

Plot 4—16 tons of manure and the same fertilizer treatment as Plot 3.

Plot 5—Check plot.

Plot 6—8 tons of manure and the same fertilizer treatment as Plot 3.

Plot 7—Green manure plot.

TABLE I—YIELDS PER PLOT.

Plot	1	2	3	4	5	6	7	Total
Wt. of snap beans....	1247	916½	680½	767¼	235½	962½	264	4803
Tons per acre.....	5.0	3.3	2.7	3.1	.9	2.8	1.1	2.7
Increase over check..	1011½	681	445	531¾	.....	457	28½	.....
% increase over check	420.5	289.2	190	225.7	.....	194	12.1	.....

The value of extra nitrogen, particularly manure, is shown very graphically by the above table, although plot 3, which did not receive any manure, is showing up better than it did with sweet corn and dry beans. The fertilizer treatments were costly in relation to the value of the crop as will be shown by the following table. The manure was valued at $2.50 per ton and the other fertilizers at the 1922 spring prices as follows:

Nitrate of Soda.....$53.00 per ton
Tankage..... 33.00 " "
Acid Phosphate..... 16.50 " "
Potash..... 48.00 " "

TABLE II—VALUE OF CROP LESS COST OF FERTILIZER.

Plot	1	2	3	4	5	6	7
Yield in lbs. per plot...	1247	916½	680½	767¼	235½	692½	264
Value per plot.....	$24.97	$18.33	$13.61	$15.35	$4.71	$13.85	$5.28
Value of fertilizer.....	$10.00	$9.21	$3.27	$7.77	.....	$4.02	.50
Value of crop less fertilizer.....	$14.97	$9.12	$10.34	$7.58	$4.71	$9.83	$4.78
Increase over check....	$10.26	$4.41	$5.63	$2.87	.....	$5.12	$.07
% Increase over check.	217.8	93.8	119.5	60.9	.....	108.7	1.5
Acre value of crop less fertilizer.....	$119.76	$72.96	$82.72	$60.64	$37.68	$78.64	$38.24

The north half of the plots are limed on the even years at the rate of 2000 pounds of hydrated lime per acre. These applications of lime have been made in the spring of 1918, 1920, 1922.

TABLE III—LIME.

Plot	1	2	3	4	5	6	7	Total
Lime.....	623¼	448¾	319	411	119¼	375	119	2415¼
No lime.....	623¾	467¾	361½	356¼	116¼	317½	145	2388
Difference	-½	-19	-42½	54¾	3	57½	-26	27¼
Per cent. .	-.08%	-4.2%	-13.3%	13.3%	2.5%	15.3%	-21.8%	1.1%

The small fluctuations recorded can scarcely be considered significant, although it is noteworthy that there is a decrease in yield on the limed portions of the green manure plots and an increase in yield on the limed portions of the plots receiving light applications of manure.

Variety Test of Fruits.

The Hansen Hybrid plums planted in 1921 blossomed in 1922 but did not set more than a few scattering plums. Golden Delicious apples fruited for the first time on top grafts which had been set two years previously. The grafts have grown vigorously and evidently fruit freely on young wood. A planting of approximately 70 red Delicious trees was made on the Horticultural Farm in order to give this variety the commercial test of which it now appears worthy. The trees which had been grown in the Thompson Orchard indicate that the tree is entirely hardy and that the fruit as produced under New Hampshire conditions is not of large size but is of good color and quality. The chief question in regard to planting this variety for commercial purposes is as to the quantity of fruit which it will produce over a series of years. Should it compare favorably with Baldwin as a heavy bearing variety, it will undoubtedly become one of the commercial apples of this region. Observations have been made on new varieties which have been grown in other sections, and the decision has been reached to include in the test orchard the varieties Chautauqua and Cortland which were originated at the New York Experiment Station. Both of these varieties are fall apples which give promise of being of considerable merit. The Rochester peach and Latham raspberry will also be added to the list of varieties under test.

Pruning Experiment with Young Apple Trees.

The trees planted in 1919 have been pruned to the vase form, semi-leader and full leader types of head as in previous seasons. Records have been made on increase in trunk diameter and the amount of growth removed in pruning. The summary of these records is given in the following table:

	Vase form Head	Semi-Leader Head	Full Leader Head	Unpruned
Inches diameter Mar. 1921....	1.0	1.1	1.0	0.7
Inches diameter Mar. 1922....	1.26	1.36	1.18	0.91
Inches increase diameter.....	0.26	0.26	0.18	0.21
Inches twigs pruned 1921.....	275.4	314.4	323.2	
Inches twigs pruned 1922.....	419.6	459.5	453.9	

The pruning of the trees has been heavy in 1921 and 1922 in order to shape the heads. It is probable that the relative severity of the pruning will be very much decreased from this time on. The semi-leader trees have thus far been pruned in exactly the same manner as the full leader trees, but in the season of 1923 the leaders will be suppressed and growth directed into the main foundation branches. This experiment should prove to be of considerable interest if carried on for a number of years. Records will be made on the time consumed in pruning for each type, relative costs of spraying, and other orchard experiments and yields of fruit and the proportion of different grades as determined by color and size will be recorded.

Fertilizer Experiments in the Peach Orchard.

The crop of peaches was destroyed by injury to the fruit buds by cold weather in March, 1922. The only records taken, therefore, have been records of trunk diameter increase which gauge the relative growth of trees in different plots. As had previously been indicated, those trees which receive nitrogen are of greater size than those which do not, the results apparently being the same whether the nitrogen is applied alone or in combination with other fertilizing elements.

Plant Breeding Experiment.

In the fall of 1921 sixty-four selections from high and low yielding Bonny Best tomato plants were made by Mr. Hepler, on the basis of the yield up to September 13, the normal date for an early frost. The wet season of 1922 decreased the yield to a considerable extent. No appreciable difference is shown in total yields between the 32 plants from high yielding parents and the 32 plants from low yielding parents; but there is a very considerable difference in strain, some strains yielding as high as 6.5 pounds, others less than 2 pounds. The difference in yield in individual plants is also very marked. Further selections have been made from the most consistent yielding strains in the experiment in order to perfect a high producing early strain of Bonny Best tomatoes.

In the fall of 1921, 90 hills were selected from a 3 acre field of Green Mountain potatoes for planting in 1922, to study the effect of hill selection upon the yield. These hills varied in yield from 4 ounces per hill to 5½ pounds for the higher yielding hills. The potatoes were carried over in cold storage and were in the very best of condition when planted. Some differences were noted in the dates at which the tops of the different strains were matured. The yield data are not yet available.

In addition to the tomato and potato selection work which has been carried on under this project, work was commenced in 1922 on breeding of sweet corn. A considerable number of crosses were made between the Evergreen and the Bantam; the Crosby and the Bantam varieties. It is expected to obtain data on the inheritance of the number of rows of kernels per ear which varies widely in these varieties. It is also thought that particularly in the crosses between Crosby and Bantam it may be possible to isolate superior individuals for a new variety of canning corn.

MISCELLANEOUS INCOME PROJECTS.

Inspection, Analyses and Tests.

Three hundred and sixty samples of commercial feeding-stuffs were analyzed for the State Department of Agriculture in connection with the enforcement of the state law regulating the sale of these materials. The results of this work are reported in Bulletin No. 205 of the New Hampshire College Agricultural Experiment Station. The relative number of feeding-stuffs in the respective classes was very similar to that of the past two seasons. There was an increase in the number of poultry feeds, wheat feeds, cotton-seed meals and oil meals, and a relative decrease in the number of mixed

dairy feeds. The quality of the feeding-stuffs showed a marked improvement, and the deficiencies in guaranteed analysis were less frequent than last year. A larger number of the higher analysis cottonseed meals was found than during the year previous.

Ninety-seven samples of commercial fertilizers were analyzed for the State Department of Agriculture. The results of this work are reported in Bulletin No. 206 of the New Hampshire College Agricultural Experiment Station. There were found a relatively smaller number of low grade fertilizers than last year. In 1921 out of a total of 104 samples, 35, or over 33 per cent., of the brands contained less than a total of 14 pounds of plant food per 100 pounds, while in 1922 only 23 brands out of 97, or approximately 24 per cent. contained less than this amount. Because it costs just as much to mix, bag and ship a ton of low analysis as it does a ton of high analysis fertilizer, the total cost per pound of plant food is much less in the higher analysis goods.

Seed tests were conducted as usual for the inspection work of the State Department of Agriculture. In addition numerous samples have been tested for farmers, county agents and seed dealers. A total of 603 samples was handled by the seed laboratory during the year.

The increase in the volume of this work and the greater importance attaching to its prosecution make it imperative that a specially trained seed analyst be secured. It is planned, therefore, in cooperation with the State Department of Agriculture, to secure the services of an expert seed analyst who will devote half time to this work and half time to instruction in botany.

Advanced Registry Tests.

The following figures on the Advanced Registry activities show the total number of cows still on test July 1, 1921, plus cows entered during the year following: Ayrshires, 23; Guernseys, 92; Holsteins, 51; Jerseys, 59; Shorthorns, 13. Total, 238. 7-day tests, 27.

Potato Seed Certification.

The increased interest in certified seed potatoes resulting from the experimental work conducted along this line by the Station has made possible a beginning in the building up of a New Hampshire certified seed product. Standard rules of a very strict type have been drawn up by Mr. Butler, and 65 acres were inspected in 1921 for farmers in the state. Of this number 13.75 acres were passed. The cost of the field inspection is borne by the growers.

White Diarrhea Tests.

The number of tests made in the campaign conducted by A. W. Richardson (Poultry Husbandry) against white diarrhea has steadily increased. Starting with 4000 samples in 1918, it grew to 7000 the following year, 11,400 the next, then 20,000 and this year will be well over 30,000.

As a result of this work orders were placed in the last season in the state for over 225,000 day-old chickens from accredited flocks. From figures obtained from many purchasers of these chicks, it was found that the mortality averaged only six per cent. On the other hand, a check on 40,000

chicks purchased from non-accredited flocks outside the state, showed a mortality of at least 40 per cent. The work is self supporting, the expense being covered by a fee of ten cents for each bird tested.

Other Service Work.

Numerous requests for the analysis of various materials and for technical advice have come to the Station laboratory during the past year. Over 150 samples of materials have been analyzed, including commercial feeding-stuffs, fertilizers, insecticides and fungicides, lime, wood ashes, soils for lime requirement, etc.

CHANGES IN PERSONNEL.

The only change in personnel of the staff has been the appointment of Mr. J. T. Sullivan as assistant chemist during the leave of absence granted Mr. C. P. Spaeth.

FINANCIAL STATEMENT.

A statement of the sources of income and expenditures during the fiscal year 1921-1922 follows:

FINANCIAL REPORT TO THE UNITED STATES GOVERNMENT OF THE HATCH AND ADAMS FUNDS

For the Fiscal Year Ending June 30, 1922.

Dr.	Hatch Fund	Adams Fund
Receipts from the Treasurer of the United States, as per appropriations for fiscal year ending June 30, 1922.	$15,000.00	$15,000.00
Cr.		
By Salaries	$9,916.00	$11,460.00
Labor	1,022.40	1,257.31
Publications	804.84	.....
Postage and stationery	647.68	22.58
Freight and express	303.79	51.60
Heat, light, water, and power	600.00	.....
Chemicals and laboratory supplies	149.68	589.17
Seeds, plants, and sundry supplies	166.10	222.02
Fertilizers	158.96	.....
Feeding Stuffs	.....	342.46
Library	401.81	.....
Tools, machinery, and appliances	171.77	28.22
Furniture and fixtures	63.96	3.61
Scientific apparatus and specimens	207.15	612.01
Traveling expenses	363.69	66.52
Buildings and land	22.17	344.50
Total	$15,000.00	$15,000.00

SUPPLEMENTARY STATEMENT OF FUNDS RECEIVED FROM OTHER SOURCES THAN THE UNITED STATES

For the Fiscal Year Ending June 30, 1922.

Dr.	State	Sales	Miscellaneous Income	Total
To balance on hand	.....	$242.03	$973.89	$1,215.92
Receipts from other sources than the United States for the year ended	$5,000.00	2,910.97	13,064.35	20,975.32
Total	$5,000.00	$3,153.00	$14,038.24	$22,191.24
Cr.				
By Salaries	$3,646.00	.....	$4,818 00	$8,464.00
Labor	66.30	1,278.41	4,033.25	5,377.96
Publications	280.45	.....	155.62	436.07
Postage and stationery	143.01	17.19	319.01	479.21
Freight and express	7.20	19.61	63.76	90.57
Chemicals and laboratory supplies	.....	.....	851.09	851.09
Seeds, plants and sundry supplies	39.15	959.24	724.01	1,722.40
Fertilizers	.....	208.81	.....	208.81
Feeding stuffs	.....	209.37	68.81	278.18
Library	129.30	.....	38.35	167.65
Tools, machinery and appliances	587.42	.....	145.89	733.31
Furniture and fixtures	.....	.90	77.01	77.91
Scientific apparatus and specimens	.....	.....	127.36	127.36
Livestock	.....	.....	325.00	325.00
Traveling expenses	95.17	54.59	833.50	983.26
Contingent expenses	.....	.....	61.00	61.00
Buildings and land	6.00	62.50	185.00	253.50
Balance	.....	342.38	1,211.58	1,553.96
Total	$5,000.00	$3,153.00	$14,038.24	$22,191.24

PUBLICATIONS ISSUED.

The following publications were issued during the year:

Station Bulletin No. 200—Inspection of Commercial Feeding-Stuffs.
Station Bulletin No. 201—Inspection of Commercial Fertilizers.
Station Bulletin No. 202—Results of Seed Tests for 1921.
Station Bulletin No. 203—Report of Experiment Station Work, 1920-21.
Station Bulletin No. 204—Studies in Termite Control.
Technical Bulletin No. 19—Laboratory Studies of the Toxicity of Some Sulphur Fungicides.
Technical Bulletin No. 20—Diffusion of Carbon Bisulphide in Soil.
Technical Bulletin No. 21—Bordeaux Mixture. II. Stimulatory Action.
Scientific Contribution No. 20—On the Use of the Acetates of Copper as Fungicides.

In cooperation with the Extension Service news material is sent to all papers in the state. Information regarding the results of the experimental work is supplied through bulletins, the press, correspondence, talks at farmers' meetings and through extension demonstrations.